bulletin from

DEPARTMENT OF
EDUCATIONAL AND
PSYCHOLOGICAL RESEARCH

SCHOOL OF EDUCATION
MALMÖ, SWEDEN

educational and psychological interactions

Bierschenk, B.:

A SYSTEM FOR INTERACTIVE BEHAVIOUR SIMULATION

No. 65 January 1978

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Bierschenk, B. A system for interactive behaviour simulation. Educational and Psychological Interactions (Malmö, Sweden: School of Education), No 65, 1978.

This report presents a system for simulation of interactive behaviour strategies. The system has been constructed on the basis of a psycho-ecological model. The basic unit is an event. Each event has been concretized by means of CCTV/VR techniques and anchored in three basic paradigms of behavioural science, namely the paradigms of association, structure and process. The report shows that the structure of properties that is typical for the paradigms has an empirical foundation and the simulator is an objective and reliable instrument. Some exploratory evaluations of adaptive behaviour simulation suggest that it is mainly the association paradigm that has influenced the development of a behaviour strategy. The report concludes with some suggestions for continued research and development work.

Keywords: Behaviour theory, closed-circuit television, communication, interaction, psycho-ecology, simulation, teacher training.

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1. COGNITION AND BEHAVIOUR: SOME STARTING POINTS

Effective communication is of crucial importance for the development of effective social organisations. Deficient communication combined with rapid technological and social changes can lead to both ecological and psychological imbalance. An increasing number of environmental groups are working for ecological improvements, but young people seem to be finding it increasingly difficult to develop an integrated personality. This shows itself in stress and an inability to develop flexible behavioural strategies in interaction with other people.

One of the main problems of a post-industrial society is the communication of valid information, being able to comprehend a course of events "correctly" and being able to interact with other people in a flexible way. Thousands of people have taken part in so-called sensitivity or confrontation groups in order to develop their sensitivity in interaction with others and to establish meaningful relationships. The development of human self-knowledge, tolerance and insight is a goal that has swept to the fore in behavioural science research and in education. Thus a fundamental aim of research and development work in the behavioural sciences should be to create aids that can be used to teach individuals to predict correctly the consequences of the action chosen in answer to something that has happened.

If individual people are to be able to achieve successful interactive behaviour in relation to others, they must develop behaviour strategies, i.e. shape their behaviour according to "preformulated hypotheses". But there must be a structure, i.e. the person in question must act according to a plan, if a goal-oriented interaction process is to evolve.

From a behavioural science point of view we are particularly interested in being able to map mechanisms that produce and reproduce behaviours and in studying how the individual's perception and evaluation steer and control behavioural changes. Expressed more specifically, this means a study of the individual's cognitive construction of a situation and the way in which this influences the development of behavioural patterns. The questions that have guided our research and development work are:

1. Can we define conceptionally basic behavioural science models and give the models an intersubjective empirical foundation?

2. Can we develop a psycho-ecological model and construct a system for an interactive behaviour simulation that can be described in terms of observable behaviour?

3. Can we develop objective and reliable instruments for steering and controlling the effects of a simulation process?

People observe, evaluate and integrate information about themselves and their environment differently during different phases of development. We know, for example, that people have different cognitive models, which means among other things that social rules and conventions are interpreted differently. Thus a person's behaviour is assumed to be a function of his cognitive models, the purpose of which is to provide him with a system of rules for interpreting and using available information.

Each meaningful behaviour is based on knowledge and evaluations. The ability to structure a situation and receive ecological information presupposes a certain cognitive development. If there proves to be a gap between knowledge and the behaviour required by a particular situation, a person reacts affectively and is unable to consider possible alternative behaviours. The ability to function pro-socially and cooperatively requires a behavioural training for which we have hitherto lacked well-established knowledge and suitable instruments. Thus it is a highly important research task to study on which theories the behaviour interpretations of individual people are based.

2. BASIC MODELS IN BEHAVIOURAL SCIENCE: A CONCEPTIONAL DEFINITION

The basic idea behind teaching educational and psychological theories should be that an interpretation of human actions cannot take place independently of theories of behaviour. Theories and models of behaviour could be of help to the individual in finding out how the environment influences a person, how he reproduces the experiences and how earlier experiences influence new ones. In this connection we shall assume that many different theories of behavioural science exist but that they are all based on one of the following basic models (paradigms): (1) the association paradigm, (2) the structure paradigm and (3) the process paradigm.

It is mainly the S-R theories based on the reflex arc paradigm that have been fundamental to interpretation of the behaviour of animals and people. Behaviour is regarded primarily as a "response" to "stimuli" that exist outside the individual.

The antithesis is mainly formulated within the framework of the gestalt theories, based on the structure paradigm. Gestalt is a German word with no exact equivalent in English and therefore this concept will be used as it stands, with no attempt made to translate it. The thesis of a predetermined structure, i.e. a predisposition of the genes,is fundamental to the interpretation of behaviour. Intellectual behaviour is interpreted as a result of biological processes and an experience of insight occurs through a new structuring of the individual's visual field. This means that nothing external (i.e. experiences in the present or in the past) can cause this formation. Learning is less important compared to processes of maturing.

The synthesis is formulated primarily within the framework of the theory of general systems, based on information feedback and control. The basic factor in the interpretation of behaviour is an interactive relation between individual and environment, which means that a time dimension is incorporated and experiences given a central place in the model. According to the model, awareness does not begin with awareness of objects or activities but with an undifferentiated state of mind.

2.1 The association paradigm

This paradigm, abbreviated to S-R, became at the beginning of the twentieth century the building block for theory-formation in behavioural science. The S-R theories formed during the 1930's are based mainly on the

assumption that new reactions can be replaced by means of "cues" that have some connection with old behaviours. By carefully identifying these cues and introducing new behaviours at suitable points in a sequence of behaviours, new habits could be established.

During the 1940's and '50's, however, new components were introduced into the S-R model. Two different behavioural levels are now differentiated, namely (1) automatic-reflexive behaviours and (2) behaviours mediated via internal representation and symbolization, i.e. higher mental processes. Moreover on the second level, two different types of behaviour are differentiated. One is called "instrumental behaviours", while the other was named "cue-producing responses". The first type comprises all intentional motor behaviours that an individual carries out for the purpose of creating a change in relation to his environment. The other type has been defined as complex problem-solving, language, thoughts and images that mediate socially complex behaviours.

Thus, from a S-R theoretical point of view,upbringing and education are in principle responses or reactions to conditions in the individual's environment. Children are brought up by manipulation of socially acceptable behaviour, where desired behaviour is rewarded and undesirable behaviour is prevented (blocked). During the years at school, learning takes place in accordance with Skinner's "reinforcement" of correct responses in agreement with carefully worked out plans for the successive building up of increasingly complex behaviours.

If we now transfer this description to a teacher-pupil situation, it could be described like this: The teacher wishes to <u>reinforce</u> the pupil's <u>positive</u> behaviours by a <u>reward</u>, such as by encouraging the pupil. Nondesired reactions are expected to be blocked. In order to get the pupil to react eventually in the desired way, the teacher makes use of systematic influence (successive approximations), i.e. adjustment to the class takes place by means of small steps. The teacher waits for desired reactions from the pupil, which he then reinforces. In order to succeed in his attempts, he avoids asking indiscreet questions, since he does not want the pupil to have negative experiences of school. Moreover he tries to find out what the pupil likes and finds positive. This is exploited by the teacher and he reinforces it by letting the pupil do what he enjoys doing.

2.2 The structure paradigm

A predetermined structure, i.e. a predisposition in the set of genes was the building block of the theoreticians who developed theories of a gestalt. The assumption presupposes inborn developmental processes, which follow an internal timetable and an internal pattern, which can be delayed or destroyed by deficient stimulation. Congenital factors are assumed to be decisive for the individual's development of a behaviour pattern. On the basis of the genetically conditioned cognitive structure, one also assumed that human behaviour is guided by a system of gestalts. These gestalts, which follow each other, always form a whole, i.e. they cannot be reduced to associations, combinations or empirical origin (experiences), since they both have their origin in the nervous system and, as far as their formation is concerned, are determined by maturity and perception.

Gestalts always consist of a whole and strive towards fulfilment. If a gestalt is not fulfilled, an incomplete situation exists that exerts pressure and demands fulfilment. Since structuralization is a predetermined process, which by necessity sooner or later forces perception upon itself, it is repeated every time a situation demands it, i.e. the structure reproduces itself. Gestalts tend to make themselves known, but it is always the most important gestalt that emerges first.

If we now transfer this description to a teacher-pupil situation, we could describe it in the following way: The teacher apprehends the teaching situation as a whole or a unit, within which one detail is picked out among many possible ones. This detail becomes particularly prominent, while the others recede into the background. The teacher's intention is to investigate the structure in the teaching situation, since by understanding it, he can change the structure in order to facilitate Aha-experiences in the pupil. In this he always addresses himself to an individual pupil, i.e. his actions are based essentially on dyadic situations. The teacher concentrates wholly on the pupil in question, in order to map his background and action pattern. He wants to form a complete impression while at the same time trying to get the pupil to gain "insight" about himself and the situation in which he finds himself. He hopes to be able to get the pupil to abstract and to integrate his abstractions, i.e. complete incomplete situations. The relation between foreground and background give the situation its content, namely. By what he says and does, the teacher wishes to gain information about the pupil and get the pupil to work through his unfinished gestalt. The teacher symbolizes

the pupil's "incomplete ego". What is of interest is the immediate situation in which the pupil finds himself, how the pupil acts and feels at a particular moment (the present). The pupil's action is dependent on the uniform field that encompasses both himself and his surroundings. The teacher tries to get a complete impression, both in order to map how the details (gestalts) are related to each other in the "system" school or "home-school-community", and also to get to grips with the pupil's mental life. The teacher then starts from the assumption that the pupil's gestalt formations are unclear but that they have form and organization. For if they had been totally shattered, the individual would be unable to function at all. Non-closed gestalts are defined as incomplete tasks or non-complete situations. The importance of the situation is brought out and the teacher focusses his actions on achieving changes in the pupil's consciousness.

2.3 The process paradigm

According to the process theoreticians an event is the building block in a theory of behaviour. Starting from the way in which the individual reacts to stimulation, it can be said that the individual's adjustment to his environment demands that there must be similarities between the individual's state (biologically, psychologically) and the state of the environment.

Since experiences and practice are included in the model, the cognitive structure is linked to the individual's own prerequisites. The individual's cognitive development consists of continuous restructuralizations. This means that it must be possible to maintain a sufficient number of structural properties in a given structure while others are transformed to a new structure. In this way continuity is maintained. This process can also be viewed as a reorganization of the individual's frame of reference, i.e. cognitive structures, which have been established in the past, are corrected.

A correction of cognitive structures presupposes that the individual can formulate hypotheses and can accept or reject them. This means that abstracted ecological information is checked against a background of established criteria, which are individual specific. This control of ecological information is required if the effects of individual specific experiences are to be used in a gradually evolving transformation of cognitive structures.

As a result of the individual's adjustment to different conditions, the content of the information changes, which leads to new processes of transformation. When the individual relates different events with each other,

experiences arise. Perceptual experiences are not looked upon as learning in the classic sense. It is the effects of the exercises that determine the individual's cognitive structure and not the contrary.

If we now transpose this description to a teacher-pupil situation, the following can result: In his actions the teacher takes into consideration two main key concepts (1) messages and (2) check of messages. He regards the classroom as a system where information is mediated and checked. This implies an active utilization of the opportunities offered by a group of pupils for communication and control of information. His purpose with this system is to mediate information that is meaningful to the individual, i.e. information that the individual can check against his own hypotheses. The teacher's intention is to develop the pupil's sensitivity in perceiving a course of events. It can be difficult for the pupil on his own to develop flexible behaviour strategies in interaction with others in the class. The teacher tries with the help of the class to make the pupil act, in order to give the pupil a chance to observe others' reactions to his actions. Another goal is to let the pupil experience how his own thoughts affect his way of looking at himself and at the environment provided by the class.

If a communication process is to arise, it is necessary that the participants feel secure. By letting the pupils work together, the teacher tries to create this sense of security and thereby a prerequisite for the pupil's ability to analyze his own actions and in that way gain answers to his questions. When the teacher lets the pupils work on tasks that necessitate interaction, a feedback of information takes place. This feedback also applies to actions that the pupil is aware of (i.e. they are directly controlled by the pupil). The teacher himself tries to create unambiguous messages. He does this by describing rather than evaluating. In addition he strives to give specific rather than general judgements. The teacher takes care that the pupil personally accepts the information mediated by the situation in question.

of how far the student teacher's development of a behaviour strategy is sensitive to behavioural science paradigms that presuppose (1) external steering and control, (2) internal steering and control and (3) rules for logical operations.

In order to make the interactive behaviour simulation more concrete, the development will be given of a simulated course of action in a subject, where the structure paradigm appears to lie behind the suggested actions. So as to describe the assumptions underlying the construction, the suggested courses of action and the pupil behaviours are presented, together with an a priori assignment of the scenes to their theoretical paradigm. It should be mentioned that it proved to be easier to anchor the consequences in the association paradigm and the process paradigm than in the structure paradigm. An account of the concrete content of the scenes and their theoretical anchorage may be found in Frost (1975, 1976).

Initial scene

Scene no. 1

Mrs Larsson and her son Göran (G) are sitting on two chairs outside the door of a classroom. They give a passive impression - sit silently and have no contact with each other. Footsteps are heard approaching and the mother jumps. When she sees the teacher, she rises hastily and pulls G up from his chair, placing him beside her. G looks nervously at the floor and moves slightly behind his mother. The mother introduces herself as Mrs. Larsson and G's mother. The teacher greets the mother and then holds out his hand to shake hands with G. G retires behind his mother and refuses to shake hands. The mother says: "G is so terribly frightened, I'm sure he won't stay here after I go". The scene is cut here and a voice asks: "What would you do now?"

Subject (S) suggests the following course of action: "Try to talk to G."

The experimenter (E) classifies and shows scene no. 8:

Scene no. 8

Goal of the course of action: The teacher turns directly to G and asks him straight out if he thinks it is unpleasant to come to school. The teacher wants to see both how G reacts to a direct approach and to hear if he can give an explanation.

Consequence: The teacher asks G if he finds it strange and unpleasant to come to a new class. G looks at the floor and presses himself against his mother. As soon as the teacher has finished speaking, the mother answers

in G's place. She says that G is always so frightened when there is something new and especially if she can't be there. The scene is cut when the mother stops speaking. The mother gives G no chance to reply.

Link to the structure paradigm. The teacher wishes to get as much information as possible about G. In accordance with the principles of gestalt psychology,the teacher concentrates on the entire personality of the pupil, i.e. posture, pitch of voice, gestures and facial expression are considered to be important components. By approaching G directly, the teacher tries to ask G about his anxiety and thereby employ another principle from gestalt psychology, namely confrontation. The aim is to expose G to "worry-provoking training". G is to work through his worry, although with the support of the teacher. In this here-and-now experiences are important. This training is intended to give G the opportunity to understand the process that is taking place within him more realistically.

An account of the whole sequence of the suggested course of action and the consequences shown together with the respective theoretical link may be found in Bierschenk (1977).

3.1 Operationalization of the paradigms

As their first assignment the assessors of a panel of 21 behavioural scientists were asked to state the content of the description of the paradigms (see Bierschenk, 1978) in the form of key-words. This preparation took about two months. On the basis of the key-words, an assessment form was drawn up. The characteristics that the assessors were to assess on a nine-point scale with the end-points "does not emerge at all" (1) and "emerges clearly" (9) are those given in Table 1.

The order of sequence for the separate statements has been arranged randomly for each individual assessor. For the assessment of the video-recorded scenes random orders have been generated and when they are assessed the scenes are shown in twenty-one random series, i.e. one for each separate assessor.

As is shown in Table 1, the factor-affiliation of the statements confirms our a priori hypothesis. Only two statements "Correction of earlier established structures" and "Sensitivity to viewpoints of others" need to be re-placed, and even there the intention can be discerned. Both also correlate substantially with the dimension stated by the a priori hypothesis. It is also noticeable that the statements describing the respective paradigms not only correlate substantially with the dimension in question, but also provide so-called

Table 1. Characteristics of the association, structure and process paradigms: A priori and factor analytically determined property structure

Content	Rotated factor P	A	S	Com	A priori determination
Structuring of environment	83	-03	08	69	P
The group´s demand for adaptation	79	-03	06	63	P
Own actions are made conscious	79	-01	22	67	P
Consideration of each other´s experiences	78	-05	27	68	P
Creation of greater interaction	71	-12	21	56	P
Creation of opportunities for structurization	18	-06	75	59	S
Creation of "Aha" experiences	09	-08	74	57	S
Confrontation to achieve change	17	-07	66	47	S
Correction of previously established structures	30	-10	64	50	P
Concentration on the whole	00	-33	56	31	S
Sensitivity to viewpoints of others	45	07	49	45	P
Concentration on the present	26	-27	36	27	S
Reinforcement of positive behaviours	03	-77	08	60	A
Repetition of successful behaviours	07	-75	10	57	A
Encouragement of desired behaviours	07	-74	10	58	A
Search for reinforcement (interests)	-03	-70	04	49	A
Utilization of existing habits	04	-68	07	47	A
Distraction of attention from negative experiences	02	-57	02	32	A
Systematic influence (successive approximation)	24	-72	05	26	A
λ	5.16	2.88	1.63		
%	27	42	51		

marking variables (factor loading $\geqslant .50$), with the exception however of the statement "Concentration on the present". (The details of the analyses are reported in Bierschenk, 1978.)

The rotation to a simple-structure factor loading matrix shows both all the properties that are to characterize such a matrix and a structure whose psychological interpretation noticeably agrees with the a priori hypothesis. The fact that the statement "Correction of previously established cognitive structures" and "Utilization of earlier experiences", has been looked upon as belonging to the structure paradigm is probably a result of the way in which the statement is formulated. The two concepts "correction" and "established" imply static conditions. In addition another concept that is important for the process paradigm namely "experiences", lacks a sufficiently unambiguous causal relation. The statement "Making possible a mutual control of information", does not appear either to have been formulated in such a way as to communicate the interactive component, "sensitivity to the viewpoints of others". The wording seems to have been interpreted more with regard to preservation and maintenance of the conventional order than was really intended, namely sensitivity to the viewpoints of others with the purpose of achieving cooperation and readiness to change one's own standpoint and to permit others to change the positions they have taken up.

To obtain a coefficient for maximal reliability, the alfa coefficient (α_{max}) has been calculated for the respective dimensions. The α_{max} values calculated are for the association paradigm .96, the structure paradigm .92 and the process paradigm .98. In every case α_{max} fulfil the reliability requirements that can be made on good objective tests.

3.2 Behavioural science anchorage of video-recorded scenes

Investigations (see Gibson, 1966) show that our perception of a geometric presentation of the physical world is usually extremely precise and reliable. Moreover several independent observers need as a rule very few instructions to be able to make exact and correct observations concerning events presented in the form of pictures (see Kennedy, 1974). A study of the development of the sense organs (see Bower, 1974) shows that in our judgements and decisions we seem to work primarily from visual information. Auditive information and information mediated by the other senses take second place.

The primary goal in behavioural science is to describe and analyze the behaviours that characterize different systems, mainly psychological. If in this context we can for the time being accept the statement that a system

can only described in terms of observable behaviours, we must necessarily be able to agree on the conventions. With this point of departure, a system's condition is not an inherent characteristic, but every system, even SIR, is real and exists in the description we impose on the system.

The task of the A, S and P factors in Table 1 is to function as information-carrying variables and as such as a reference system for student teachers. The task of the reference system is to provide a set of functional limitations. Thus the student teacher must in some way be able to discover and integrate the effects of the not directly available causal variables, if he is to be able to interact with SIR. By constructing an interactive behaviour simulator, anchored in different behavioural science models, we hope to be able to study whether and to what extent the implicit cognitive structure of individual people can be approximated by means of these models. If we assume that all exchange of knowledge and information between people can only take place within certain tolerance limits (defined through implicit models), a study of the basic structures of different cognitive systems should be of fundamental importance for all educational activities.

Cues are built into the scenes that to a greater or lesser degree refer to the paradigms described. But the set also contains scenes that are not anchored in the paradigm. These are regarded as being without information, i.e. as placebo scenes. The assessment panel mentioned will now be used to operationalize the allotment of the scenes to their respective paradigms. Considering the information-carrying cue systems built into SIR, the set of scenes should contain four different and orthogonal latent dimensions. Thus, the main aim of having a panel assessment of the behavioural science content of the scenes is to convert non-explicitly formulated and often not even noticed teaching goals of a psychological nature into a precise and analyzable procedure. A description of the set of scenes and the details of the analysis are reported in Bierschenk (1978). Therefore only the results of the rotated factor structure are given in Table 2.

The results in Table 2 can be described in the following way: The scenes in which the affordance-structure refers to the association paradigm also mainly define Factor II or Dimension A. Only two scenes show high correlation with Factor IV. These will be regarded in future as placebo-scenes. The same applies to the scenes that prove to be marking scenes (factor loadings $\geq .50$) for Factor IV, although there are also correlations $\geq .30$ with Factor II.

Table 2. A priori and factor analytically determined structure in video-recorded situations (scenes)

Content	Rotated factor P	A	S	E_1	E_2	Com	A priori determi-nation
Teacher tries to find out what Göran is interested in (maths?)	-11	81	04	09	-12	69	A
Teacher suggests that the class does some maths (with the mother)	-03	71	03	-04	-01	51	A
Teacher suggests that the class does some maths (without the mother)	-04	69	02	-03	06	49	A
Teacher promises Göran he can look after the aquarium	-01	71	09	-09	13	54	A
Mother and Göran sit down	06	63	-06	-34	-02	53	A
Teacher suggests that the class does a painting of the summer (with mother)	01	67	-02	-08	06	45	A
Teacher talks to Göran about Asterix	-02	68	29	-07	-06	55	A
Teacher asks Göran what he is interested in (maths?)	-05	61	11	-30	-15	49	A
Teacher shows Göran the fishes, Göran looks shyly	00	61	-06	-37	11	52	A
Teacher suggests that the class does a painting of the summer	05	63	-07	01	09	42	A
Aquarium: "Perhaps you have one too?"	08	59	15	-29	-05	47	A
Teacher tries to distract, shows the aquarium	-00	56	-12	-39	08	49	A
Göran stands close to his mother and looks down at the floor	02	01	57	-20	16	39	S
Teacher talks to Göran's former teacher about him	-03	07	76	-10	05	60	S
Teacher visits Göran's home	08	-04	78	-15	-04	64	S
Teacher talks to school welfare counsellor about Göran	07	-07	72	-15	-04	55	S
Teacher talks to mother at school	21	-02	68	-14	11	54	S
Teacher talks to mother on telephone	23	05	67	-06	10	51	S
Teacher lets the class draw their families	18	10	54	-03	18	37	S
Teacher has a private talk	24	27	53	-17	-01	44	S
Teacher lets Göran talk about the figures in his drawing	02	37	42	05	13	33	S/A
Teacher tries dice game + Stefan	83	03	04	-01	09	69	P
Teacher tries contact exercise: A ship ... (with mother)	79	10	08	-05	06	65	P
Teacher tries contact exercise: A ship ... (without mother)	79	02	-03	-04	15	65	P
Teacher tries contact exercise: Sawing in pairs (without mother)	77	-08	07	-02	08	60	P
Teacher tries to get Göran to function: Collage + Stefan	75	08	05	-13	13	61	P
Teacher tries to get Göran to function: Collage	76	02	-02	10	-01	59	S
Göran is given a seat by the door	74	-11	15	-23	-00	64	P
Teacher suggests that class makes tour of school	67	-09	16	-32	05	59	P
Teacher tries to introduce Göran into group of pupils (without mother)	66	-03	15	-14	23	53	P
Teacher conducts a group conversation	65	24	16	-03	-20	55	P
Teacher introduces the appointed sponsors	65	06	07	-22	13	49	P
Teacher wants to try to let Göran act a part	47	-19	30	03	05	35	S
Teacher tries to introduce Göran into group of pupils (with mother)	47	18	12	-23	12	35	P
Noisy class: Aren't we going to start soon?	40	-14	04	-05	13	20	N
Look at aquarium from the door into the classroom	-03	32	04	-64	14	53	E (A)
Göran says: I don't want to	08	08	15	-50	17	32	E (N)
Göran and his mother stand outside classroom door. Teacher: Come in	38	14	22	-44	34	53	P
Teacher shows the class: Making physical contact	16	11	05	-62	08	43	A
Mother holds Göran tenderly near the aquarium	05	53	-04	-50	02	54	E (A)
Seeking contact: Good friends	-02	26	03	-60	05	43	A
Göran stands inside the room: Unhappy	09	03	05	-38	18	19	E (N)
Göran stands inside the room: Cries	03	07	07	-37	04	15	E (N)
Teacher suggests that Göran and his mother listen to the class	21	16	05	-48	13	33	S
Teacher suggests that the pupils say their names (with mother)	38	04	18	-32	04	29	E (P)
Teacher introduces the new pupils	38	-05	22	-48	-06	43	E (P)
Teacher puts arm round Göran's shoulders: It will be all right	07	27	05	-48	-02	32	E (N)
Teacher asks: Where did Göran go during the break?	20	-02	32	04	28	22	E (N)
Initial scene	06	02	11	-31	-00	11	E (N)
Teacher asks mother to leave the classroom	01	-03	23	-11	69	54	E (N)
Teacher says: Goodbye, Mrs. Larsson. Göran half-rises	15	00	12	-13	68	52	E (N)
Class (group pressure) is used in the farewell scene	27	-03	08	-14	58	43	E (P)
Teacher says that the mother is to go home quietly	15	11	19	-39	52	49	E (S)
Mother is sent home: Not suitable for her to stay	14	29	14	-27	48	42	E (N)
λ	10.86	6.78	3.55	2.38	1.60		
%	20	33	39	44	47		

The scenes whose affordance-structure refers to the structure paradigm also define in all essentials Factor III or Dimension S. There are however, two scenes "Teacher wants to try to let Göran act a part" and "Teacher tries to get Göran to function: Collage" that a priori belong to Factor III. The factor loadings show, however, that they are affiliated to the process paradigm. Scene "Teacher lets Göran talk about the figures in his drawing" can a priori be allocated to both the structure and the association paradigms. The same result is shown by the factor loadings. But since the scene correlated somewhat more highly with Factor III than with Factor II, it has been placed with the structure paradigm. Scenes "Teacher suggest that Göran and his mother listen to the class" and "Teacher says that the mother is to go home quietly" seem to be "information-less" and will be regarded from now on as placebo scenes.

The scenes that define Factor IV or Dimension E have a priori been considered "information-less", and this has been confirmed. The same applies to Factor V, which is defined by the scenes that concretise the teacher's attempts to separate mother and son. As such it should be possible to use the scenes within any paradigm, since the separation task should not normally be linked to any definite behavioural science starting-point. In this way Factor V is really a confirmation that we have succeeded when constructing the simulation in keeping the separation scenes apart from any anchorage in any of the three paradigms. Thus succeeding with the separation task is wholly independent of a particular starting-point in SIR or a particular behavioural science point of view.

The factors shown in Table 2 should be looked upon as condensed statements about the linear relations that exist between the information-carrying cues that have been built into the scenes. The factor analytical testing of the a priori hypothesis about the behavioural science anchorage of the scenes (the scenes' latent dimensions) has in only 11 % of the cases led to a regrouping. Thus the empirical analysis shows very good agreement with the theoretical analysis on which the behavioural science anchorage of the scenes is based.

The scenes that correlate with the respective dimensions are also in most cases marker scenes, which permits unequivocal statements about the affordance-structure that characterizes each scene. Furthermore an estimation of the reliability shows generally very high α_{max}-values. For the whole set of scenes α_{max} is .97. With regard to the information-carrying cues built into the scenes, we can establish that the judgements are objective ($\alpha_{max} \geq .89$). In conclusion the information-carrying cue system in SIR can be said to fulfil the demands made on objective instruments.

4. AN ANALYSIS OF SIMULATED STRATEGIES OF BEHAVIOUR

Within a particular unit of time, only a limited number of interactions can occur. Thus the time variable structures the interaction process and makes it into a multi-step decision-making process. From the point of view of the student teacher or e.g. the pupil (in the form of E's selection of scenes), SIR functions psycho-ecologically, i.e. behaviour strategies are developed on the basis of an adaptive decision-making process. The goals of both the student teacher and the pupil are preliminary and are exposed to changes during the development of an interactive behaviour strategy as both the student teacher and the pupil learn to understand the nature of the task.

Adaptive behaviour simulation means that the observations (the scenes) have been arranged with regard to an interval of time and the evaluation refers to an analysis of the consequences that each separate suggestion for action has had for the student teacher in his interaction with SIR.

If we regard the scene sequences generated by the simulation process as Markov chains, we can say that the simulation process is in different states (t_1, t_2, t_3, ...). The fact that the simulation process is in state k at time n can in accordance with Fisz (1971) be given as $t_k(n)$ and its probability we denote with

$$P\left(t_k(n)\right) = \pi_k(n)$$

The vector

$$\pi(n) = \left[\pi_1(n),\ \pi_2(n),\ \pi_3(n),\ \ldots\right]$$

then contains the probabilities that the simulation process will generate at random the different states (t_{10}, t_{nm}) at n point in time. Moreover since the simulation process must at a certain given point in time, be in a particular state and cannot be in more than one state, the probability vector $\pi(n)$ must add up to 1, i.e.

$$\sum_k \pi(n) = 1$$

In our case the probability that the simulation process changes from state i to state j is unknown and must be estimated. For the estimation of probabilities, see Kemeny & Snell (1960).

If the simulation process can in N steps reach any state irrespective of

the starting point, the generated scenes can be looked upon as regular Markov chains. Since SIR acts equifinally, this assumption can be taken as being confirmed. A regular Markov chain also presupposes that there is no "transient state". Since the simulation process must lead to a final state, this requirement is also fulfilled.

4.1 Analysis of experiment 1

If the idea of Markov chains is now applied to the data from our first experiment (see Bierschenk, 1978), it becomes possible to construct a matrix that contains transition probabilities. The matrix is presented in Table 3.

Table 3. Transition probabilities for observed transitions from experiment 1

State i / j	E	A	S	P
I	.00	.60	.40	.00
A	.31	.56	.06	.06
S	.00	.35	.41	.24
P	.18	.09	.18	.55

i = states preceding in time
j = states following in time
I = initial state

Starting from the proportions presented in Table 3, the following two questions will be studied:

1. To what extent is the simulation process influenced by the information carrying cue-systems built into the scenes?

2. To what extent will future simulation processes generate proportional distributions corresponding to those presented in Table 3?

As can be seen from Table 3, the simulation process has in 56 % of the cases generated A scenes. Only in 6 % of the cases does an A scene follow an S scene or a P scene. In 31 % of the cases, however, an E scene follows an A scene and so on.

Before question 2 is answered, it will be re-formulated into the following hypotheses:

H_0: The simulation process generates scene sequences with the same proportional distribution of A, S, P and E scenes.

H_1: The simulation process generates scene sequences with differing proportional distributions of A, S, P and E scenes.

The hypotheses have been formulated from the assumption that possible changes in the proportional distributions from one experiment to another or from one term to another depend solely on the process that is described by means of a transition matrix. By analyzing separate scene sequences, it is naturally also possible to study individual processes. The assumption on which this analysis is based is that the student teacher's (Ss's) decision after seeing a particular scene is only influenced by the decision made after the immediately preceding scene. More concretely, the assumption means that the decision made by the Ss after the initial scene has been shown not influence the prediction of the final result.

When the Ss know neither which scenes belong to which paradigms nor with what probability a certain scene follows a suggested action, uncertainty exists. Moreover there is a priori no reason to believe that any one paradigm would have greater steering effects on the simulation process than any other. A good starting point for testing H_0 could be to assume the same probability (p) for the different states of the simulation process. This means that each factor can be allotted an a priori probability of $p = .25$. In this way we get an asymptotic vector a, i.e.

$$a = (a_1 = a_2 = a_3 = a_4).$$

The vector determines to what extent the simulation process is in different states irrespective of the paradigm. Since the vector limits the course of the simulation process, it will be called the limitation vector.

If the paradigm has not been of any importance for the simulation process, there should after a trial run exist approximately the same proportional distribution as stated in the limitation vector. If the matrix in Table 3 is pre-multiplied with vector $a = (.25, \ldots, .25)$, we get as a result a new vector a'. This shows the following a posteriori distribution

$$\begin{array}{cccc} & E & A & S & P \\ a' = (& .12, & .40, & .26, & .21) \end{array}$$

The trials during experiment 1 show that the paradigm has influenced the simulation process. In 40 % of the cases the simulation process generates A scenes. Compared to the others, this is a very pronounced result. Thus, the Ss suggestions for action seem to generate sequences of events whose affordance-structure mostly refer to the characteristics of the association paradigm.

4.2 Analysis of experiment 2

The basic theorem for regular Markov chains (see Kemeny & Snell, 1969, p. 69) says that the results from experiment 1 are independent of the present state of the Ss, i.e. that it should be possible to generalize the results for future situations. This would mean for the interpretation of a' that successive trial runs increasingly resemble the initial vector's distribution of the proportions. Thus the process should be independent of a certain given initial distribution and should maintain an equilibrium. To test if and to what extent the probabilities strive towards an equilibrium, the transition probabilities of experiment 2 are shown in Table 4.

Table 4. Transition probabilities for observed transitions from experiment 2

State i	j	E	A	S	P
I		.53	.20	.20	.08
A		.30	.35	.22	.13
S		.28	.22	.39	.11
P		.44	.11	.11	.33

i = states preceding in time
j = states following in time
I = initial state

If the matrix in Table 4 is pre-multiplied with the vector a = (.25, ..., .25) we get as a result an a' vector that shows the following a posteriori distribution

$$\begin{array}{ccccc} & E & A & S & P \\ a' = (& .39, & .22, & .23, & .16) \end{array}$$

The trial run during experiment 2 shows that the paradigm has influenced the process. In 39 % of the cases the simulation process generates E scenes, which should constitute a clear result of the partly different goals described in Bierschenk (1978). In addition there is further accentuation of the low proportion of P scenes, while the proportion of A and S scenes is almost equally large. Despite a clearly more even distribution of A and S scenes, the simulation process has led both to a powerful increase in the proportion of E scenes and further reduction in the number of P scenes. But before more far-reaching conclusions can be drawn, a larger random sample of measuring objects and a more uniform execution of different experiments would be required. Meanwhile, this result could perhaps be seen as an indication that (despite the popularity of the process models in the general debate) dynamic models increase in complexity and that it is therefore much more

difficult to apply the principles in solving a concrete task in an interaction process than is the case with the association and structure paradigms.

5. SOME CONCLUDING REMARKS

An interactive behaviour simulation based on psycho-ecological principles requires an operationalization of the "affordance structure" of the events. An event is namely the most important unit in a psycho-ecological analysis of interactive behaviour strategies. In order to be able to represent the affordance structure in an event, three "basic variables" have been abstracted and built into SIR that are indirectly to cause effects and in that way influence the individual's cognition and suggestion for action.

A development of methods for constructing interactive behaviour simulators within various social sectors such as teacher training, nursing and pre-schooling could create the prerequisites for the design of laboratory training, i.e. training based on the student's own teaching experiences. The nature of the experiences or the essential basic parts of an interactive behaviour strategy would then be defined by the actions that generate the strategy in question. But since the actions are in their turn dependent on given and controllable conditions, the experiences from a laborative training can be subjected more directly to diagnosis and synthesis than experiences in general can.

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Abstract card

Bierschenk, B. A system for interactive behaviour simulation. Educational and Psychological Interactions (Malmö, Sweden: School of Education), No. 65, 1978.

This report presents a system for simulation of interactive behaviour strategies. The system has been constructed on the basis of a psycho-ecological model. The report shows that the simulator is an objective and reliable instrument. The report concludes with some suggestions for continued research and development work.

Indexed:
Behaviour theories, closed circuit television, communication, interaction, psycho-ecology, simulation, teacher training.

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Bierschenk, B. A system for interactive behaviour simulation. Educational and Psychological Interactions (Malmö, Sweden: School of Education), No. 65, 1978.

ISSN 0070-9263